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ABSTRACT

The National Survey of Science, Mathematics, and Social Studies Education was conducted in the spring of 1977 as part of the National Science Foundation's comprehensive needs assessment program. The survey utilized a national probability sample of districts, schools, and teachers. Approximately 10,000 teachers, principals, superintendents, and state and local supervisors were included in the sample. Response rates ranged from 72 percent for local supervisors to 90 percent for state supervisors. A major purpose of the survey was to provide the National Science Foundation with the accurate and up-to-date information needed to make decisions about future funding of curriculum development and teacher education activities. The sample design, and procedures used in instrument development and data collection, are described in section one. Selected results are presented in section two, and section three discusses some of the implications of these results for teacher education, such as teacher characteristics, sources of information, the use of various instructional materials and techniques, and areas in which teachers need additional assistance. (Author/MJB)

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1977 NATIONAL SURVEY OF SCIENCE, MATHEMATICS, AND SOCIAL STUDIES EDUCATION: IMPLICATIONS FOR TEACHER EDUCATION

by

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PART I. INTRODUCTION

A. Background and Purpose of the Study

Since the mid-1950's, the National Science Foundation (NSF) has supported a variety of attempts to improve science, mathematics, and social science education at the pre-college level. As part of its course content improvement program, NSF funded the development of such curriculum materials as PSSC Physics, BSCS Biology, SMSG Mathematics, and Man: A Course of Study, to name just a few. NSF has also sponsored a large number of workshops, institutes and conferences aimed at increasing the subject matter competency of teachers and assisting teachers in implementing various curriculum materials. However, very little is known about the impact of these activities. Most studies of the extent of use of the NSF-supported curricula have been local in nature, or they have suffered from major design flaws which cast doubts on the results. Consequently, NSF curriculum development and teacher education efforts have been conducted in the absence of reliable data about the needs of teachers and students.

A major purpose of this large-scale National Survey of Science, Mathematics, and Social Studies Education was to provide NSF with the accurate and up-to-date information needed to make rational decisions about future funding of curriculum development and teacher education activities. This survey is part of a large-scale needs assessment supported by NSF; the other aspects of the needs assessment include a series of case studies and a comprehensive review of the literature. While the survey covers a broad range of topics, including course offerings, curriculum usage, teaching techniques, and teacher education needs, this paper focuses on particular issues which have implications for teacher education.

The sample design, and the procedures used in instrument development and data collection are described in the following sections; selected results are presented in Part II, while Part III discusses some of the implications of these results for teacher education.

B. Sample Design

The National Survey of Science, Mathematics and Social Studies Education utilized a national probability sample of districts, schools and teachers. The sample was designed so that national estimates of curriculum usage, course offerings and enrollments, and classroom practices could be made from the sample data. The sample design also ensured that estimates could be made for various subpopulations such as those in a particular region or a particular type of community.

A probability sample requires that every member of the population being sampled must have a known positive chance of being selected. The sample design for this survey ensured that every superintendent, science, mathematics and social studies supervisor, principal, and teacher of science, mathematics and social studies in grades K-12 in the 50 states and the District of Columbia had a chance of being selected.

The samples of superintendents, supervisors, principals, and teachers to be contacted in this survey were selected using a multistage stratified cluster design. A sample of approximately 400 public school districts was selected from 102 primary sampling units (PSU's) consisting of standard metropolitan statistical areas, counties, and groups of contiguous counties. In each district, one school with at least one of the grades 10-12 and one school with at least one of the grades 7-9 were selected. In a subsample of two of the four districts in each sample PSU four additional schools were selected--two with grades included in the grade range 4-6 and two with grades in the K-3 grade range.

All superintendents in the sample districts were asked to complete brief questionnaires. The superintendent was also asked to provide the names of the district K-6 and 7-12 science, mathematics, and social studies supervisors (or other persons who could answer questions about district programs in these subject areas); all of these supervisors were asked to complete questionnaires.

The principal of each sample school was asked to complete a questionnaire and to provide a list of the school's science, mathematics and social studies teachers and the number of classes of each subject the teacher taught. These lists were used to select 6 teachers (2 science, 2 mathemat-

ics, and 2 social studies) from each 7-9 and 10-12 sample school as well as a particular class to be studied in depth. The teacher lists from K-3 and 4-6 sample schools were used to select 3 teachers per school and a particular subject (and class, if applicable) to be studied in depth.

C. Instrument Development

An initial review of the research literature was conducted to locate previous studies of K-12 science, mathematics and social studies education and to identify important variables. A preliminary set of research questions and data sources was developed, submitted to NSF, and revised based on NSF feedback. Questionnaire items which could be used to answer these research questions were written (or in some cases items appearing in earlier studies were revised) and preliminary drafts of the questionnaires were prepared.

Preliminary drafts of the questionnaires were reviewed by NSF, by 18 consultants with expertise in science, mathematics, and social studies education and by representatives of a number of professional organizations including the American Association for the Advancement of Science, the American Psychological Association, the Social Studies Education Consortium, the Educational Products Information Exchange and the national associations of both state supervisors and local district supervisors of science, mathematics and social studies education. The questionnaires were revised based on feedback from the various reviewers, approved by the Committee on Evaluation and Information Systems (CEIS) of the Council of Chief State School Officers and by the Office of Management and Budget.

D. Data Collection

The Chief State School Officers in the states with sample schools were asked for permission to contact sample districts in their states. District superintendents were subsequently contacted, and once they had granted permission, questionnaires were mailed to sample members.

Follow-up activities used to increase the response rate included the use of Thank-You/Reminder postcards. The resulting response rates were 90 percent for state supervisors, 73 percent for superintendents, 72 percent for district supervisors, 84 percent for principals, and 76 percent for teachers.

PART II. RESULTS

A. Teacher Characteristics

Teachers were asked to indicate the number of years they have taught, including 1976-77 as a full year even though the data were collected during that year. The average amount of teaching experience was 11.5 years; and the averages for teachers in the 12 subject/grade range categories of interest in this study (K-3, 4-6, 7-9, and 10-12 science, mathematics, and social studies) are quite similar.

As expected, very few elementary teachers are male, and the proportion of male teachers increases with grade. Only 4 percent of K-3 teachers are male; the figures are 25 percent for grades 4-6, 59 percent for grades 7-9, and 75 percent for grades 10-12. On the whole, differences among the three subject areas are minor.

Sizable numbers of teachers have earned one or more degrees beyond the bachelor's, with percentages ranging from 29 percent for K-3 teachers to 56 percent for 10-12 teachers (see Table 1). In addition, many teachers have taken courses for college credit in recent years. As shown in Table 2 more than 40 percent of all science, mathematics, and social studies teachers have taken a course for college credit in 1976 or 1977.

To provide additional background information about science, mathematics, and social studies teachers, sample teachers were asked about their qualifications for teaching. Elementary teachers rated their qualifications for teaching each of 4 subjects--math, science, social studies, and reading; these results are shown in Table 3. Nearly two-thirds of elementary teachers feel "very well qualified" to teach reading. The corresponding figures for mathematics, social studies, and science are 49 percent, 39 percent, and 22 percent, respectively. At the other end of the scale, 16 percent of elementary teachers feel "not well qualified" to teach science, compared to 6 percent or fewer in each of the other three areas.

As shown in Table 4, most secondary science, mathematics, and social studies teachers teach all of their courses within a single subject area; the percentages are 76 percent for grades 7-9 and 85 percent for grades 10-12. The sample secondary teachers were asked to indicate if they are

Table 1. Percent of Teachers Receiving a Degree Beyond the Bachelor's, by Subject and Grade Range

Grade Range	Mathematics			Science			Social Studies			Total		
	Yes	No	Miss-ing	Yes	No	Miss-ing	Yes	No	Miss-ing	Yes	No	Miss-ing
K-3	34	66	1	28	72	0	23	76	1	29	71	1
4-6	34	64	2	30	70	1	33	66	1	32	66	1
7-9	45	55	0	50	50	0	51	48	1	48	51	0
10-12	55	45	0	54	44	2	58	41	1	56	43	1
Sample N	1672			1679			1478			4829		

Table 2. Year of Last Course for College Credit, by Subject and Grade Range

Grade Range	Mathematics			Science			Social Studies			Total		
	Prior to 1976	1976-1977	Miss-ing	Prior to 1976	1976-1977	Miss-ing	Prior to 1976	1976-1977	Miss-ing	Prior to 1976	1976-1977	Miss-ing
K-3	56	42	2	47	49	4	48	50	2	51	47	4
4-6	50	47	3	46	51	3	52	44	4	49	47	3
7-9	63	36	1	56	44	1	51	48	2	57	42	1
10-12	55	42	3	56	42	3	56	42	2	56	42	2
Sample N	1672			1679			1478			4829		

Table 3. Elementary Teachers' Perceptions of Their Qualifications to Teach Each Subject

Subject	Percent of Teachers			
	Not Well Qualified	Adequately Qualified	Very Well Qualified	Missing
Mathematics	4	46	49	1
Science	16	60	22	2
Social Studies	5	54	39	1
Reading	3	32	63	2

Sample N = 1667

Table 4. Percent of Secondary Science, Mathematics and Social Studies Teachers Teaching Various Combinations of Subjects, by Grade Range

Subjects Taught	Grade Range		Total
	7-9	10-12	
Mathematics Only	28	27	28
Science Only	24	27	25
Social Studies Only	24	31	27
Mathematics and Science Only	3	5	4
Mathematics and Social Studies Only	1	0	1
Science and Social Studies Only	1	2	1
Mathematics, Sciences and Social Studies Only	0	0	0
Other Combinations of Subjects	19	8	14
Sample N	3162		

teaching any courses that they do not feel adequately qualified to teach and, if so, to specify the courses. Thirteen percent of secondary science teachers are currently teaching one or more courses for which they feel inadequately qualified, compared to 12 percent of social studies teachers and 8 percent of mathematics teachers. The majority of the teachers listed courses in their sample subject area; for example, most of the science teachers who indicated they are inadequately qualified to teach one or more courses were referring to courses within science. The problem of teaching "out of field" is apparently a problem within each major subject area rather than across subject areas.

B. Time Spent in Science, Mathematics, Social Studies and Reading Instruction

Each elementary teacher was asked to write in the approximate number of minutes typically spent teaching mathematics, science, social studies and reading. The average number of minutes per day typically spent in K-3 and 4-6 instruction in each subject is shown in Table 5; to facilitate comparisons among the subject areas only teachers who teach all four of these subjects to one class of students were included in these analyses. Note

Table 5. Average Number of Minutes per day Spent Teaching Each Subject in Self-Contained Classes, by Grade Range[1]

Subject	Grade Range		Total Average Number of Minutes
	K-3 Average Number of Minutes	4-6 Average Number of Minutes	
Mathematics	41	51	44
Science	17	28	20
Social Studies	21	34	25
Reading	95	66	86
Sample N	467	302	769

[1]Only teachers who indicated they teach mathematics, science, social studies, and reading to one class of students were included in these analyses.

that in each grade level, the amount of time spent is greatest for reading, followed by mathematics, then social studies and finally science. However, the difference between reading and the other subjects decreases from K-3 to 4-6 because the amount of time spent on reading decreases and the amount of time spent on each of the other subjects increases.

C. Federally Funded Curriculum Materials

One measure of the impact of the federal curriculum development efforts is the extent of use of these materials. The survey found that by far the most extensive usage of federally funded curriculum materials is in science in grades 7-12; a total of 60 percent of the districts are using at least one of these materials, with 41 percent using more than one. Usage in elementary science and elementary and secondary social studies is lower (33 percent, 25 percent and 24 percent, respectively). At both the K-6 and 7-12 grade levels, district usage of any federally funded mathematics curriculum materials per se is below the 10 percent level. However, it should be noted that, as was intended, many of the innovative ideas introduced in the federally funded materials have now been incorporated into the commercially available textbooks which are being used in many districts.

As mentioned earlier, NSF has sponsored a variety of teacher education activities during the last 20 years. The survey found that many more science and mathematics teachers than social studies teachers have participated in one or more NSF-funded workshops, institutes, or conferences. Also, the level of participation generally increases with increasing grade level. While fewer than 10 percent of elementary school teachers or social studies teachers have attended any of these NSF-sponsored activities; more than one-third of all high school mathematics teachers and almost half of all high school science teachers have participated in at least one such activity.

D. Teacher Needs for Assistance

Teachers were given a list of areas and asked to specify for each whether: (1) they do not usually need assistance, (2) they would like assistance from a resource person (e.g., a coordinator, a consultant, or another teacher) but receive little or none, or (3) they would like assistance and receive adequate assistance. Table 6 summarizes the data by indi-

Table 6. Percent of Teachers With Varying Numbers of Areas in Which They Need Assistance, by Subject and Grade Range

Subject/Grade Range	Need for Assistance			
	0 Areas	1-4 Areas	5 or More Areas	Unknown[1]
Total	23	42	32	3
Mathematics				
K-3	25	48	27	1
4-6	30	41	26	3
7-9	21	55	23	1
10-12	26	45	29	0
Science				
K-3	25	32	33	10
4-6	17	32	45	6
7-9	19	43	37	2
10-12	17	34	35	4
Social Studies				
K-3	33	35	26	5
4-6	23	38	36	3
7-9	22	46	29	3
10-12	22	39	37	2

[1]This includes all teachers who omitted 6 or more parts of the question.

cating the breakdown of teachers who would like assistance but receive little or none in varying numbers of areas. Twenty-three percent of the teachers did not indicate a need for additional assistance in any of the areas; 42 percent specified from 1 to 4 areas, while 32 percent indicated a need for additional assistance in 5 or more areas.

The complete results for individual areas of need are presented in Table 7 for all science, mathematics, and social studies teachers. Note that more than 75 percent of science, mathematics, and social studies teach-

Table 7. Science, Mathematics and Social Studies Teachers' Needs for Assistance

	Do Not Need Assistance	Do Not Receive Adequate Assistance	Receive Adequate Assistance	Miss-ing
Establishing instructional objectives	70	15	11	4
Lesson planning	83	9	5	4
Learning new teaching methods	34	43	18	4
Obtaining information about instructional materials	30	43	24	4
Obtaining subject matter information	50	28	18	5
Implementing discovery/ inquiry approach	47	36	12	5
Using manipulative or hands-on materials	48	33	14	5
Maintaining equipment	62	19	14	4
Working with small groups of students	60	29	6	4
Maintaining discipline	82	8	6	3
Articulating instruction across grade levels	57	29	8	6

ers do not usually need assistance in lesson planning, actually teaching lessons, and maintaining discipline. These results were quite consistent across the 12 grade range/subject categories examined in this study (K-3, 4-6, 7-9 and 10-12 science, mathematics, and social studies).

What are the greatest needs? Very few teachers (about one-third) feel able to learn new teaching methods and to obtain information about instructional materials without assistance from a subject matter resource person. While some teachers indicated they are getting assistance, more than 40 percent believe they are not receiving adequate assistance in each of these areas.

Many of the federally funded curriculum development projects, as well as some of the more recent commercially developed materials, depend upon a discovery or inquiry approach. However, fewer than half of all science, mathematics, and social studies teachers feel they are competent in this area without assistance from a coordinator or other resource person. Thirty-six percent indicated they would like assistance but receive little or none; only 12 percent would like assistance and feel they are receiving adequate assistance. Similarly, approximately half of these teachers feel inadequate to the task of using manipulatives or hands-on materials without outside assistance but only 14 percent feel they are getting the necessary help.

Other areas where sizable numbers of teachers feel the need for more assistance than they are currently receiving include working with small groups of students (29 percent), articulating instruction across grade levels (29 percent), and obtaining subject matter information (28 percent). The latter area appears to be a greater problem in elementary science and in elementary and secondary social studies than in mathematics or secondary science.

E. Sources of Information Used by Teachers

Teachers were also given a list of possible sources of information about new developments in education and were asked to rate the utility of each. The results showed that many science, mathematics, and social studies teachers rely on other teachers for information; approximately half of them rate this source "very useful" while most of the others consider teachers "somewhat useful." Other particularly valuable sources of information for teachers include journals and other professional publications (especially for teachers in the higher grades), college courses, and for elementary teachers, local in-service programs. Principals, local subject specialists, federally sponsored workshops, meetings of professional organizations, and publishers and sales representatives are also considered useful sources of information by quite a few teachers, while the majority of teachers rated teacher union meetings and state department personnel as "not useful."

F. Instructional Materials and Techniques

The textbook continues to play a central role in science, mathematics, and social studies classes. With the exception of K-3 science and social

studies, virtually all science, mathematics and social studies classes use published textbooks or programs.[1] While most classes use a single textbook or program, approximately one-third use multiple textbooks. In most districts, teacher committees and individual teachers are heavily involved in selecting the textbooks to be used. In many cases principals, superintendents and district-wide supervisors are also involved in these decisions. Very few districts involve students, parents or school board members to any great extent in the textbook selection process.

Lecture and discussion are the predominant techniques used in science, mathematics, and social studies classes. Discussion occurs "just about daily" in half or more of these classes. Approximately two-thirds of the classes in each subject have lecture once a week or more, with many of these having lectures "just about daily."

Science and social studies classes are generally more likely than mathematics classes to use alternative activities such as library work, student projects, field trips, and guest speakers. Similarly, films, filmstrips, film loops, slides, tapes, and records are more frequently used in science and social studies classes than in mathematics classes. On the other hand, individual assignments, chalkboard work, and tests occur more frequently in mathematics classes than in social studies or science classes. Televised instruction, programmed instruction, computer-assisted instruction, and contracts are rarely used in any of the three subjects. Finally, simulation activities (e.g., role-play, debates, panels) are common in social studies but rare in science and mathematics.

Principals were asked about the availability of various types of equipment and teachers were asked about the actual use of these. The results showed that some types of equipment are available in many schools, but are used in relatively few classes. For example, while more than three-fourths of elementary schools have microscopes, only 28 percent of the K-3 science classes and 56 percent of the 4-6 science classes ever make use of them. Similarly, while approximately half of all schools with grades 7-9 have hand-held calculators, only 10 percent of 7-9 science classes and 11 percent

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[1]Approximately one-third of K-3 science and social studies classes use no published textbook or program.

of 7-9 mathematics classes use calculators. As a final example, while 36 percent of 10-12 schools have computers or computer terminals, only 8 percent of 10-12 science classes and 16 percent of 10-12 mathematics classes ever uses them.

The use of "hands-on" or manipulative materials is most frequent in science classes, with 48 percent of the classes using them at least once a week compared to 38 percent of mathematics classes and 24 percent of social studies classes. However, even in science approximately one out of four classes use manipulatives less than once a month.

In science classes, the use of manipulatives increases with increasing grade level. Meter sticks and rulers are frequently used at all grade levels, while living plants and animals are frequently used in the lower grades, and balances and scales are frequently used in the higher grades. Interestingly, science teachers who have attended one or more NSF-sponsored activities are considerably more likely than other science teachers to use manipulative materials in their classes. This is not the case for mathematics or social studies teachers.

In mathematics, use of manipulatives is more common in the lower grades. Games and puzzles, activity cards or kits, and numeration and place value manipulatives such as rods and blocks are frequently used in grades K-6. At all grade levels, non-metric measurement tools are more frequently used than metric measurement tools. In social studies, use of manipulatives is again more common in the lower grades, with maps, charts, and globes being used quite frequently.

Science and mathematics teachers were asked about the use of the metric system in their classes. As shown in Table 8, use of metric concepts increases with grade level in science classes; approximately 90 percent of the 7-9 and 10-12 science classes make use of the metric system. In mathematics, on the other hand, use is higher in the lower grades; by grades 10-12 only 56 percent of mathematics classes use metric concepts. In addition, mathematics classes are more likely to use the metric system only in a special unit, while science classes are more likely to introduce the concepts in a special unit and then use them throughout the course.

Table 8. Percent of Math and Science Classes Which Treat Metric Concepts in Each of a Number of Ways, by Subject and Grade Range

Use of Metric Concepts	Mathematics					Science				
	K-3	4-6	7-9	10-12	Total	K-3	4-6	7-9	10-12	Total
None Used	26	13	20	43	24	42	31	10	7	26
Special Metric Unit Used	42	43	34	7	35	22	19	13	8	17
Special Metric Unit and Used Through Course	8	22	22	5	15	13	20	40	44	27
Introduced as Needed	22	19	23	44	25	14	26	36	38	26
Missing	2	3	1	1	2	9	4	1	3	5

G. Factors Which Affect Instruction in Science, Mathematics, and Social Studies Education

Insufficient funds for purchasing equipment and supplies, and lack of materials for individualizing instruction are serious problems affecting K-12 science, mathematics, and social studies instruction according to all groups queried (teachers, principals, and state and local supervisors). Inadequate facilities are also considered a serious problem in science at all grade levels. Interestingly, all groups except teachers consider inadequate articulation of instruction across grade levels to be a serious problem.

Several problems appear more serious in the elementary grades than in the secondary grades, including lack of teacher planning time in all three subjects. The belief that these subjects are less important than others and inadequate time to teach these subjects are also considered major problems for elementary science and social studies. It is interesting to note that all groups except the teachers themselves consider inadequate teacher preparation and lack of teacher interest to be major problems in K-6 science instruction.

Inadequate student reading abilities appear to be a major problem in science, mathematics, and social studies education in grades 7-12. In addition, educators perceive lack of student interest in these subjects to be a serious problem in grades 7-12 but not in grades K-6.

PART III. IMPLICATIONS FOR TEACHER EDUCATION

The results of the 1977 National Survey of Science, Mathematics, and Social Studies Education can be used by those responsible for teacher education in making decisions about pre-service and in-service programs. For example, current certification requirements often allow a secondary teacher to become certified in a single subject, such as biology, with only minimal exposure to other areas of science. The survey found that, while the science teacher does not often teach mathematics or social studies, the biology teacher quite often teaches a section of chemistry or physics. Teacher certification departments should take note of the fact that approximately 10 percent of the secondary science, mathematics, and social studies teachers feel inadequately prepared to teach one or more of the subjects within their discipline that they are currently teaching. Given the reality that many teachers will have to teach more than one subject within a discipline, a restructuring of teacher certification course (or competency) requirements may be in order.

Mathematics educators may be concerned about the data related to use of the metric system. The majority of 10-12 mathematics teachers indicated that metric measurement tools are "not needed" in their classes, and more than 40 percent of the 10-12 mathematics classes never use metric concepts. In contrast, almost all of the 10-12 science classes make use of the metric system.

Science educators will be distressed to see that despite the many efforts to strengthen elementary science education, science continues to receive considerably less emphasis than other subjects in the elementary school classroom. The average number of minutes spent in science instruction in self-contained K-6 classes is less than half that spent on mathematics and less than one-fourth that spent on reading. Elementary teachers' perceptions about their qualifications for teaching the various subjects are consistent with the amount of time that is generally spent in instruction in

these areas, with the percent of teachers feeling "not well qualified" to teach science considerably greater than for reading, mathematics or social studies. Science educators may also be concerned that, while the use of manipulatives is more widespread in science than in mathematics or social studies, 9 percent of the science classes never use manipulative materials and another 14 percent do so less than once a month.

Educators interested in all three of these subjects may be concerned about the lack of change in classroom instruction in recent years. While many educators recommend the use of a diversity of materials and teaching techniques, most classes still use a single textbook, and lecture and discussion continue as the dominant techniques.

In addition to inferring needs from the data related to classroom practices, teacher educators can look directly at the needs perceived by teachers. Sizable numbers of teachers of each subject expressed a need for additional assistance in several aspects of instruction, most notably learning new teaching methods, obtaining information about instructional materials, implementing the discovery/inquiry approach, and using hands-on materials.

How can teachers obtain the necessary assistance? Historically, the primary emphasis in teacher education has been pre-service preparation of teachers. However, the findings of this survey and other studies show that a reordering of priorities may be necessary. Teacher turnover rates have declined to the point where the average teacher has been teaching for more than 10 years. Thus, there is often a very long period of time between initial training and certification and retirement from the profession. Regardless of the strength of their pre-service preparation, teachers can be expected to develop professional needs during the course of their careers, and it is essential that a system be developed to help teachers meet these needs.

According to the results of this study, colleges and universities have the opportunity to attempt to meet the needs of a large number of practicing teachers. More than 40 percent of the K-12 science, mathematics, and social studies teachers have taken a course for college credit during the last two years. Whether this is due to the desire for professional growth on the

part of many teachers, or is primarily a reflection of teacher renewal requirements, the fact remains that the teachers are there to be reached. The findings of this study can be used to structure courses which have a higher likelihood of improving instruction in science, mathematics, and social studies.